All other water diversions along the river are shoreline diversions. The largest is GCID's Hamilton City Pumping Plant on an oxbow off of the Sacramento River. It diverts up to 3,000 cfs of water into the Glenn-Colusa Canal. Although many improvements have been made to its screening system, fish protection remains inadequate and improvement efforts continue. An environmental impact report is being prepared to describe actions involved in resolving the problem. In addition, hundreds of unscreened diversions located along the river operate primarily in the spring-through-fall irrigation season. Approximately 20 of these are large (>250 cfs). Efforts are presently being made in cooperation with the irrigators and resource agencies to screen these larger diversions.

The damage to fisheries and the riparian system associated with each of the problems in the upper river varies according to the type of water-year and water delivery operations. The diverse and cumulative nature of these variables requires a holistic remedy to achieve ecosystem restoration in the Sacramento River. The most important factors causing mortality are being addressed in various ways with interim or emergency actions.

Fish passage over the 80-year-old ACID diversion dam must be improved. A feasibility study is being conducted to identify alternatives to achieve this goal. ACID canal operations need to be standardized to protect Sacramento River chinook salmon. This involves draining canal water through waste gates only on channels with fish barriers at their confluence with the river, limiting waste-gate releases to 5 or 10 cfs to minimize attraction of salmon from the river, and providing total containment of canal waters when toxic herbicides are present.

Fish passage at RBDD is a longstanding problem that has been partially solved through reoperation. This interim fix has constrained water diversion, and the longer term resolution needs to incorporate fish passage and survival and water delivery. There is the potential that the U.S. Bureau of Reclamation (Reclamation) research pumping facility at RBDD will allow "gates up" operation at RBDD from mid-September through mid-May and allow Reclamation to fulfill its water contract commitments. With the gates raised, fewer squawfish congregate below the dam, thereby reducing predation on juvenile salmon as they pass under the dam gates. This also provides unimpaired upstream and downstream migration for all anadromous fish in the river. During the period when the gates are open, the gravels in the reach immediately above the dam are available for chinook salmon and steelhead spawning, thereby, avoiding the need to compensate for its loss. Fish losses and delayed migration, however, will still occur during the 4 months the dam gates are lowered.

Natural stream meander, river and floodplain interactions, and riparian plant communities have been damaged by levees, bridges, bank protection, and other types of inchannel structures. Where feasible, natural stream meander should be allowed. To enhance this process, it is likely that riprap would be removed in specific areas formerly subject to bank protection activities. Bridge piers and abutments restrict stream channel processes. Long-term remediation of this problem might include future redesign to accommodate river meander when bridges across the Sacramento River are replaced.

Unnatural levels of predation typically occur in the Sacramento River near instream structures, such as diversion dams, bridge piers and pilings, and support structures for diversion pumps. These provide structure and shade which attract predators. This problem can be reduced in the long term by redesigning, removing, or reoperating these structures to minimize the creation of predator habitat, and by providing escape cover in the form of shaded riverine aquatic habitat.

Competition is primarily between naturally and hatchery produced fish and is typically for food and rearing area. The extent of adverse effects of the interaction between hatchery and natural fish has not been adequately investigated in the Central Valley, although Hallock (1987) reported that yearling steelhead released into Battle Creek consumed large numbers of naturally produced chinook salmon fry. Competition may be a suitable subject for focused research and adaptive management. In the interim, hatchery release strategies and schedules should be evaluated to determine opportunities to reduce or eliminate the potential for competition. Although the potential adverse effects of hatchery fish on wild stocks of salmon and steelhead have not been adequately investigated, there is every reason to expect adverse impacts in addition to competition including predation, interference with reproduction, increased fishing mortality due to mixing in the ocean

fishery, disease introduction, loss of local adaptations, and genetic introgression. Hatchery operations should be evaluated and changed to minimize all these potential problems.

Harvest will remain an important element that influences the abundance of Central Valley anadromous fish populations. Harvest strategies need to emphasize the protection of naturally produced stocks with a focus on improving spawner returns for winter-run and spring-run chinook salmon and steelhead. Harvest has been severely restricted in recent years to maximize the return of winter-run chinook spawners, at a high economic cost to fishermen in terms of lost opportunities to harvest abundant fall-run chinook.

Improved management of anadromous fish populations, particularly chinook salmon and steelhead, requires the development and implementation of a comprehensive coded-wire tagging and recovery program for hatchery stocks. Data derived from these marking programs are important to assess the contributions of hatchery fish to the fisheries and escapements. Experimental studies can be designed to evaluate the interaction of hatchery and wild fish to that future management direction can be established.

In the interim, the annual production levels of each hatchery should be evaluated to ensure that the hatchery goals are consistent with ecosystem restoration and the recovery of listed species. In the longer-term, hatcheries should not produce fish at levels which exceed the mitigation requirements and other production goals.

Toxins from mine drainage on Spring Creek, enter the river by way of Keswick Dam and threaten survival of salmon and steelhead when sufficient dilution flows are not available from Shasta Lake. Recurrent non-point discharges of agricultural pesticides and herbicides occur, which may also adversely affect juvenile fish populations, other aquatic organisms, and riparian and riverine aquatic vegetation.

DESCRIPTIONS OF ECOLOGICAL MANAGEMENT UNITS

KESWICK DAM TO RED BLUFF DIVERSION DAM ECOLOGICAL MANAGEMENT UNIT

The Keswick Dam to Red Bluff Diversion Dam reach (59 miles from RM 302 to RM 243) includes the mouths of Ash, Bear, Cow, Inks, Stillwater, Anderson, Battle, and Paynes creeks draining Mount Lassen, and of Spring, Clear, and Cottonwood creeks draining the Coast Range and Klamath Mountains. Much of the river in this reach flows through confined canyons, although portions have a broader floodplain. About 4 miles below Keswick Dam, the river widens to about 500 feet before entering the alluvial plains of the Sacramento Valley below Red Bluff. This reach includes much urbanized and residential river frontage, but is not contained by levees as is common on the downstream reach. More than 75% of naturally spawning chinook salmon in the Sacramento River use this reach, while the remaining spawners use the reach from RBDD to Princeton, near Colusa.

RED BLUFF DIVERSION DAM TO CHICO LANDING ECOLOGICAL MANAGEMENT UNIT

The Red Bluff Diversion Dam to Chico Landing Reach (49 miles from RM 243 to RM 194) includes the mouths of eastside tributaries of the Sacramento River that drain Mount Lassen and the northern Sierra Nevada, including Antelope, Mill, Deer, Pine, Rock, and Big Chico creeks. Westside streams that drain the upper valley and parts of the Coast Range include Elder and Thomes creeks. South of Red Bluff, the river meanders over a broad alluvial floodplain confined by older, more consolidated geologic formations (i.e., more cohesive deposits resistant to bank erosion). The extent of river floodplain and active channel meander belt from Red Bluff to Chico Landing has remained relatively unchanged and includes a significant amount of riparian forest and wildlife.

Chico Landing to Colusa Ecological Management Unit

The Chico Landing to Colusa reach (51 miles from RM 194 to RM 143) includes the mouth of Stony Creek and no other major tributaries. In this reach, most of the high flow during storm runoff events leaves the river along the east bank and enters the expansive floodplain of Butte Basin through three major flood relief outfalls at M&T Ranch, 3B's, and Parrot Ranch, and farther downstream through the Moulton and Colusa weirs near Colusa. Much of the river downstream of Chico Landing has been subject to flood control with an extensive system of setback levees, basin and bypass outflows, and streambank protective measures, such as riprap. However, considerable riparian forest remains within the levees along the active channel. Levees in this reach are 0.25 to 1.0 mile apart.

In the Butte Basin overflow segment, more extensive bank revetment projects installed during the past 30 years by landowners and the U.S. Army Corps of Engineers (Corps) attempt to halt natural channel migration by fixing the river in a static position. It was believed that natural channel migration and meander cutoff might alter flow splits that divert a major portion of river floodflow over three major weirs into Butte Basin, where flooding volumes pose less risk to levee overtopping. Recent hydraulic simulation studies of this reach appear to indicate that the river is somewhat self-adjusting to maintain similar Butte Basin overflow volumes despite specific meander cutoffs that may occur. However, bridge structures (e.g., Ord Ferry Bridge) may be more at risk to major adjustments of the channel position within the floodplain.

Colusa to Verona Ecological Management Unit

The Colusa to Verona reach (63 miles from RM 143 to RM 80) includes the mouth of Butte Creek at the Butte Slough outfall gate, but no significant tributary inflow until the Colusa Basin drain enters the river near Knights Landing at RM 90. In past years outflow at the Colusa Basin Drain has contributed to attraction of adult chinook salmon from their normal migratory pathway of the Sacramento River. Fish that stray into the Colusa Basin Drain are subject to stranding and loss from the spawning population. High flows leave the river by way of the Colusa and Tisdale weirs. Farther downstream, most flow from the Sutter Bypass/Butte Slough and Sacramento River leaves the river again at the 3-mile-long Fremont weir and flows down the Yolo Bypass to the Delta at Rio Vista. Most of the levees in this reach are built close to the main river channel, and little riparian forest or shaded riverine aquatic (SRA) habitat remains. Leveed banks are steep, with extensive riprap and routine removal of volunteer vegetation by local reclamation districts to maintain levee stability on the confined river channel. At the turn of the century, levees were built close to the banks to help move sediment down the river to prevent natural shoals that obstructed commercial river navigation reaching Colusa and Red Bluff. This unit is the most important spawning area for striped bass, and appropriate flow velocities and water temperatures are required for successful striped bass reproduction.

Verona to Sacramento Ecological Management Unit

The Verona to Sacramento Ecological Management Unit (20 miles from RM 80 to RM 60) includes important tributary inflow from the Feather River (and from Sutter Bypass and Butte Creek during high flows) at RM 80 and from the American River at RM 60. High-flow outfall from the rivers and Sutter Bypass enters the Yolo Bypass via the Fremont Weir. As with the upstream reach, most of the levees in this reach are built close to the main river channel, and little riparian forest or SRA habitat remains.

Vision for the Ecological Management Zone

The vision for the Sacramento River Ecological Management Zone is to improve, restore, and maintain the health and integrity of the Sacramento River riverine-riparian and tributary ecosystems to provide healthy conditions for sustainable fish and wildlife populations and the plant communities on which they depend.

The pathway to this vision is through preservation and restoration of erosional and depositional channel and floodplain forming processes, riparian and wetland habitats, spawning gravel recruitment, and reducing the extent and influence of stressors. It also includes managing streamflow and flow regime in ways that benefit ecosystem health. Restoring the

health and integrity of the Sacramento River Ecological Management Zone will provide a productive and resilient foundation for the recovery of the Bay-Delta estuary and the associated fish, wildlife, and plant resources.

The main stem Sacramento River above Verona may be the most important sturgeon spawning and rearing habitat in the Central Valley, particularly in view of recent information regarding green sturgeon spawning in the river above Hamilton City.

In addition to the vision for the Sacramento River Ecological Management Zone, individual visions have been developed for ecological processes, habitats, stressors, species, and Ecological Management Units. These visions follow.

VISIONS FOR ECOLOGICAL MANAGEMENT UNITS

VISION FOR THE KESWICK TO RBDD ECOLOGICAL MANAGEMENT UNIT

The vision for the Keswick Dam to Red Bluff Diversion Dam Ecological Management Unit is to protect ecological processes where still intact; allow riparian forests to reach maturity; restore physical and successional processes; and protect and restore freshwater fish habitats that provide for migration, spawning, and rearing for chinook salmon and steelhead.

The potential activities include maintaining a flow pattern that emulates the seasonal hydrologic regime and provides adequate temperatures for rearing steelhead and winter-run chinook salmon to the extent possible while conserving the cool water pool in Shasta Reservoir. This must be done in consideration of the high level of development of water and flood storage in the upper section. Additional activities include cooperative efforts to restore some aspects of the natural hydrologic conditions of the upper Sacramento River. The Anadromous Fish Restoration Plan's (AFRP's) targets of 3,250 to 5,500 cfs from October 1 to April 30 are similar to the rates of unimpaired average flows. In addition to the AFRP base flow minimums, reservoir inflows should be released to the river to provide 8,000 to 10,000 cfs and 15,000 to 20,000 cfs flow events for approximately 10 days in March of dry and below normal years, respectively. Such flow events would support natural processes in the upper river, such as erosion, sediment transport and sediment deposition, and stream channel meander, that depend on natural flow regimes. In addition, this reach contains important year-round spawning and incubation habitat for anadromous salmonids.

The vision highlights the restoration of ecological processes that naturally create and sustain habitats needed to support and restore the endangered Sacramento winter-run chinook salmon, the threatened Central Valley steelhead, the threatened spring-run chinook populations; and species of special concern such as fall-run chinook, late-fall-run chinook, and green sturgeon. Important ecological functions of flow include maintaining and supplementing the natural stream meander and gravel recruitment processes, transporting and depositing sediment, protecting the limited riparian corridor, providing cool water for all species of fish, and preventing potential catastrophic fish losses resulting from an uncontrolled spill of toxic materials from Iron Mountain Mine (IMM) and Spring Creek debris dam overflows.

Because this Ecological Management Unit encompasses a significant portion of critical holding, spawning, and nursery area required by the endangered winter-run chinook salmon, most of the water diversions in this reach require positive-barrier fish screens installed to protect juvenile salmon and steelhead. A primary concern in this Ecological Management Unit is protecting and enhancing instream gravel resources supplied to the mainstem river by the tributaries.

Nursery areas for juvenile salmon would be improved by restoring or enhancing riparian and riverine aquatic vegetation throughout this unit, particularly in areas immediately up- and downstream of the mouths of some of the tributaries described above.

VISION FOR THE RED BLUFF TO CHICO LANDING ECOLOGICAL MANAGEMENT UNIT

The vision for the Red Bluff Diversion Dam to Chico Landing Ecological Management Unit is to protect and expand the quantity and quality of the stream meander corridor; protect the associated riparian forest and allow it to reach maturity; install positive

barrier fish screens to protect young fish; maintain flows that emulate the natural hydrology to the extent possible; and recover or contribute to the recovery of threatened, endangered, and special concern species.

The existing meander belt should be protected and improved to sustain the riparian and riverine aquatic habitat component that is important habitat for winter-run chinook salmon and steelhead, other anadromous fish species, riparian forest dependent species, such as yellow-billed cuckoo, other neotropical migrant bird species, and the valley elderberry longhorn beetle. This reach also provides important spawning habitat for anadromous salmonids, particularly fall-run chinook salmon.

Restoring endangered species and species of special concern requires that water management activities be consistent with maintaining ecological processes. These include flows that emulate the natural hydrologic regime to the extent possible and are compatible with the high level of development of water in the upper section. Important considerations include flows needed to maintain natural stream meander processes, gravel recruitment, transport, deposition, and establishment and growth of riparian vegetation.

Because this Ecological Management Unit encompasses an important portion of critical nursery and emigration area required by the endangered winter-run chinook salmon, water diversions in the section will require positive-barrier fish screens to protect juvenile fish. In addition, recent research on non-natal rearing in secondary and ephemeral tributaries indicates that these streams are important rearing habitat and refuges for young chinook salmon and steelhead in the Sacramento River system.

The broad riparian corridors throughout the unit should be connected and should not be fragmented. These corridors connect larger blocks of riparian habitat, typically greater than 50 acres. The riparian corridors should generally be greater than 100 yards wide and would support increased populations of neotropical migrants, such as the yellow-billed cuckoo, and unique furbearers, such as the ring-tail and river otter. Species such as the bank swallow will benefit from the restoration of processes that create and maintain habitat within this unit.

Nursery areas for juvenile salmon should be improved through the restoration of waterside emergent and riparian vegetation throughout the unit and particularly up- and downstream of the mouths of some of the tributaries described above.

Vision for the Chico Landing to Colusa Ecological Management Unit

The vision for the Chico Landing to Colusa Ecological Management Unit is to improve habitat and increase survival of many important fish and wildlife resources by preserving, managing and restoring a functioning ecosystem that provides a mosaic of varying riparian forest age classes and canopy structure; maintaining a diversity of habitat types, including forest and willow scrub, cut banks and clean gravel bars, oxbow lakes and backwater swales with marshes, and floodplain valley oak/sycamore woodlands with grassland understory; maintaining uninterrupted gravel transport and deposition; supporting a complexity of shaded and nearshore aquatic substrate and habitats with well-distributed instream woody cover and organic debris; setting back levees; and the installing positive barrier fish screens.

Restoring endangered species and species of special concern requires that water management activities be consistent with maintaining ecological processes. These include flows that emulate seasonal patterns typical of the natural hydrologic regime, consistent with the high level of water development in the upper section. Important considerations include flows needed to maintain natural stream meander processes and gravel recruitment, transport and deposition, and maintenance of the limited riparian corridor in this section. A long-term goal would be to set back levees in this section consistent with flood control requirements. This important concept should be integrated into any future flood control planning efforts.

Closing gaps in the shoreline riparian vegetation and nearshore aquatic habitat will be accomplished by several means. These include natural colonization or active restoration of expanded floodplain along channels; reduction of vegetation management by local reclamation districts (consistent with flood control requirements); and enhancement of channel banks by modifying levees and berms to incorporate habitat structures, such as fish groins and low

waterside berms that support natural growth and woody debris. However, in the long-term, it may be more beneficial and more cost effective to construct set back levees.

Important elements needed to attain the vision for this unit include specific processes that maintain high-quality habitat for chinook salmon and steelhead, as well as the other anadromous fish species. The continuance of the natural river migration within its meander zone is essential to create and maintain most of these habitats. A mix of solutions will be employed to reduce the need for future additional bank protection or separation of the channel from its floodplain. Floodplain management and detention measures that expand flood protection for valley residents by reducing peak flood stage within the leveed channel will also permit more undisturbed habitat to thrive within the river corridor. Measures will most likely include strategic levee setbacks, expanding flood basin outflow capacity, and new flood easements in basin lands that detain additional flood flows, thereby reducing river stage.

In this unit, broad riparian corridors should be interconnected with narrower corridors that are not subject to fragmentation. These corridors should connect larger blocks of riparian habitat, typically larger than 50 acres. These blocks should be large enough to support the natural cooling of the river by convection currents of air flowing from the cool, humid forests and across the river water. The wider riparian corridors should generally be greater than 100 yards wide to support neotropical migrants better, such as the yellow-billed cuckoo. Cavity-nesting species, such as the wood duck, and special-status species, such as the bank swallow, will benefit from restoring the processes that create and maintain habitat within this unit. The narrower corridors would be 10 to 25 yards wide.

Nursery areas for juvenile salmon should be improved by restoring waterside emergent and riparian vegetation throughout this unit.

Because this Ecological Management Unit encompasses a significant portion of the critical migration habitat required by the endangered winter-run chinook salmon, positive-barrier fish screens should be used at water diversions in this section to protect juvenile fish.

Vision for the Colusa to Verona Ecological Management Unit

The vision for the Colusa to Verona Ecological Management Unit is to improve habitat and increase survival of many important fish and wildlife resources; set back levees to improve conditions for riparian vegetation and limited stream meander; provide flows that emulate the natural flow patterns; and install positive barrier fish screens to protect young fish.

Important elements needed to attain the vision for this unit include specific processes that allow the recovery of riparian forest and nearshore aquatic habitats and maintain high-quality habitat for chinook salmon and steelhead and other anadromous fish species. Because this reach is an important seasonal component of the critical migration habitat required by the endangered winter-run chinook salmon, positive-barrier fish screens should be used at water diversions in this section to protect juvenile fish. Adverse environmental effects of the Colusa Basin Drain will be eliminated so that there are no future problems with high water temperatures, contaminants, or fish stranding.

The lack of channel capacity and proximity of levees to the river in the lower two units in this zone are the primary reasons that many habitats are degraded, discontinuous, or absent from this part of the river. There is simply no more room to restore large habitat nodes or corridors without contributing to the flood risk. This is an area where flood control, the potential for set back levees, and ecosystem restoration requirements must be carefully evaluated and integrated. While the potential for meander restoration is less feasible here than on other sections of the river, some degree of restoration is possible.

Vision for the Verona to Sacramento Ecological Management Unit

The vision for the Verona to Sacramento Ecological Management Unit is to recover, contribute to the recovery, or maintain many important fish and wildlife resources that depend on partially operational ecological processes and functions. Elements of this vision include actions to maintain a natural flow pattern; maintain high-quality nursery and migration

habitat for adult and juvenile winter-run chinook salmon and steelhead and other anadromous fish species; emulate the natural hydrologic regime to the extent possible; maintain natural stream meander processes and gravel recruitment and deposition; maintain a limited but continuous riparian corridor; provide water temperatures suitable to support chinook salmon, steelhead, and other anadromous fish; reducing potential fish losses resulting from toxic residues from agricultural tailwater; and install positive barrier fish screens to protect young fish.

Closing gaps in the shoreline riparian vegetation and nearshore aquatic habitat will be accomplished (consistent with flood control requirements) by reducing vegetation management by_ local reclamation districts and by enhancing channelbanks. The latter entails modifying levees and berms that incorporate habitat structures (such as fish groins and low waterside berms), which support natural growth and woody debris. This section presents the greatest potential for adding oxbows and arms back into the river system. These modification would enhance valley-wide flood control because an increased floodplain would disperse and carry more water. Nursery areas for juvenile salmon, splittail, and other native resident fish species would be improved by restoring waterside emergent and riparian vegetation nodes throughout this unit, particularly in areas immediately downstream of the mouth of the American River.

In this unit, narrower riparian corridors should be connected and should not be fragmented. These corridors would connect larger blocks of riparian habitat, typically greater than 50 acres. These blocks would be large enough to support the natural convection currents of air flowing from the forests across the river, causing evaporative cooling of the river. The riparian corridors would generally be 10 to 25 yards wide and would support cavity-nesting species, such as the wood duck, and provide perch and nest sites for raptors, such as the Swainson's hawk. Significant expansion of riparian habitat is only possible if lower river peak floodflow can be reduced, or where levees can be set back several hundred feet at constricted bends to create expanded floodplain nodes within the levees.

VISIONS FOR ECOLOGICAL PROCESSES

CENTRAL VALLEY STREAMFLOWS: Healthy streamflows are natural seasonal patterns in late winter and spring, which include peak flow events that support many ecological processes and functions essential to the health of floodplains, riparian systems, and anadromous and resident native fish populations. The Sacramento River has only a marginally healthy streamflow, because storage reservoirs in the upper watershed reduce flood peaks during the winter and spring, releasing the stored water during the summer months. The vision for these flow patterns can be attained by supplemental short-term releases from the major storage reservoirs to provide flows that emulate natural peak flow events.

COARSE SEDIMENT SUPPLY: The supply of sediments, including gravel, on the Sacramento River is severely impaired by reduced inputs from tributaries and blockage of upstream sources by Shasta Dam and Keswick Dam. Spawning habitat of native resident and anadromous fishes and the production of aquatic invertebrates are dependent on the amount of suitable gravel in the river. Two major sources of sediments include Cottonwood Creek and natural bank erosion. The vision is to use natural processes to provide sediments to the system and to supplement sediment introductions to the extent necessary to emulate natural conditions.

STREAM MEANDER: The meandering river process in the Sacramento River provides much of the habitat required by anadromous fish populations that depend on the river for spawning, rearing, and migration. Meander also provides the steep-sided cut banks required for bank swallows. The meander belt of the upper portion of the river above Chico Landing is reasonably healthy and functioning, while the meander belt of the lower reaches of the river has been greatly limited by river channelization, by a network of confining levees, and associated development in the river floodplain. The vision is to maintain and preserve existing areas of meander and to reactivate meander in other areas that are impaired by bank protection activities.

NATURAL FLOODPLAIN AND FLOOD PROCESSES: Natural floodplains above Chico Landing are present, but much of the floodplains

below are no longer accessible due to levee construction. Maintaining existing and restoring inaccessible floodplains are important ecological components needed to improve the health of the Sacramento River and the Delta. Actions proposed for protecting the natural stream meander corridor along the Sacramento River will contribute to improved connectivity of the river with its floodplain. The vision is to maintain existing areas where the Sacramento River seasonally inundates its floodplain and to reestablish this seasonal inundation in smaller areas that will be subject to adaptive management and focused research.

CENTRAL VALLEY STREAM TEMPERATURES: High summer and fall water temperatures continue to threaten the health of anadromous fish populations in the river. Although actions have been taken to reduce high water temperatures, low flows and the release of warm water from reservoirs in drought years remain as very serious threats to the anadromous fish populations of the Sacramento River. The vision is that stream temperatures will be manipulated to the extent possible to meet the biological requirements of aquatic organisms and that a healthy riparian and riverine aquatic corridor will contribute to shading and moderating temperatures gains in the river. Summer and fall stream temperatures are more critical for steelhead than they are for most races of chinook salmon because steelhead juveniles must rear for more than one year in fresh water, hence the vision is also to provide adequate water temperatures year-round.

VISION FOR HABITATS

RIPARIAN AND RIVERINE AQUATIC HABITATS: The vision is to maintain and restore extensive areas of riparian and riverine aquatic habitats. The primary area for this is along the Sacramento River above Colusa. However, contiguous riparian habitats are extremely important to fish and wildlife throughout all reaches of the Sacramento River, including the 143 miles below Colusa.

FRESHWATER FISH HABITAT: Freshwater fish habitat is an important component needed to ensure the sustainability of resident native and anadromous fish species. The upper sections of the Sacramento is a fall chinook salmon spawning stream of low gradient while the remainder is a valley floor low elevation stream (Moyle and Ellison 1991). The vision is that the quality of freshwater fish habitat in the Sacramento River will be maintained through actions directed at streamflows, coarse sediment supply, stream meander, natural floodplain and flood processes, and maintaining and restoring riparian and riverine aquatic habitats.

ESSENTIAL FISH HABITAT: The Sacramento River has been identified as Essential Fish Habitat (EFH) based on the definition of waters currently or historically accessible to salmon (National Marine Fisheries Service 1998). The vision for EFH is to maintain or restore substrate composition; water quality; water quantity, depth and velocity; channel gradient and stability; food; cover and habitat complexity; space; access and passage; and flood plain and habitat connectivity.

VISION FOR REDUCING OR ELIMINATING STRESSORS

WATER DIVERSIONS: Water diversions ranging from several cfs to several thousand cfs lead to the loss of millions of juvenile anadromous and resident fish. Significant progress has been made in screening the larger diversions, but screens are needed on the remaining unscreened largest, many medium-sized, and small diversions. Losses at these diversions continue to threaten the health of the anadromous fish populations. The vision is to consolidate, relocate, and screen diversions along the Sacramento River to the extent that they no longer impair other efforts to restore anadromous and resident fishes.

DAMS AND OTHER STRUCTURES: Diversion dams and other structures in the Sacramento River directly and indirectly impair the survival of adult and juvenile anadromous fish. Structures delay or prevent the upstream migration of adult fish during their spawning run, which lowers the reproductive success and viability of the entire population. These diversion structures can injure young fish as they migrate downstream or cause disorientation, making them more susceptible to predation. Predator fish that are not able to migrate upstream may congregate below these structures during times when prey species are abundant. The vision is to modify, remove, or reoperate structures in a manner that greatly lessens adverse affects on aquatic organisms.

LEVEES, BRIDGES, AND BANK PROTECTION: Most of the biological productivity in large river ecosystems occurs in the floodplain. Levees tend to sever the river from its floodplain and thereby reduce this productivity. Bridges and bank protection limit the lateral migration of the river channel. The vision is to modify or remove structures in a manner that greatly lessens adverse affects on ecological processes, habitats and aquatic organisms.

PREDATION AND COMPETITION: Predation and competition are natural ecological functions. For example, Sacramento pikeminnow are a large native predatory minnow which evolved along with other fishes in the Sacramento River system. Predation by this species under natural environmental conditions is a natural ecological function. However, large-scale alterations of habitat, streamflow, and the construction of instream structures has provided an advantage to predatory species by eliminating escape cover for young fish and providing types of habitat that harbor predatory fish. Unnatural levels of predation or competition can result in adverse effects to important sport and commercial fisheries and species of concern. The vision is that predation and competition will be lessened by removing, redesigning, or reoperating inwater structures and diversion dams, altering hatchery practices, and restoring riparian and riverine aquatic habitats.

CONTAMINANTS: Heavy metals from Spring Creek are a continuing problem for fish in the upper Sacramento River, as well as non-point sources of contaminants in the lower river reaches, such as agricultural return flow at Knights Landing. The vision is that contaminant effects will be reduced to levels that will not impair efforts to restore anadromous and resident fish populations and other aquatic and terrestrial species.

HARVEST OF FISH AND WILDLIFE: The legal and illegal harvest of anadromous fish within the river, estuary, and ocean constrains recovery of wild populations of anadromous fish in the Sacramento River. Reducing the fraction of the wild population harvested will most likely be necessary to allow recovery of populations to a healthy condition. The vision is that harvest strategies will complement efforts to rebuild anadromous fish populations.

ARTIFICIAL PROPAGATION OF FISH: Stocking hatchery-reared salmon and steelhead in the Sacramento River and some of its tributaries supports important sport and commercial fisheries and mitigates loss of chinook salmon and steelhead from the construction of large dams and reservoirs. Hatchery fish also supplement the numbers of naturally spawning chinook salmon and steelhead in the river. However, hatchery salmon and steelhead may impede the recovery of wild populations by competing with wild stocks for food and space. Hatchery-raised stocks, because of interbreeding, may not be genetically equivalent to wild stocks or may not have the instincts to survive in the wild. If these stocks breed with wild populations, overall genetic integrity suffers. Improvements in hatchery practices are necessary to ensure recovery of wild salmon and steelhead populations. The vision is to operate hatcheries in a manner that is fully integrated into ecosystem management and restoration of naturally spawning anadromous fish.

STRANDING: Chinook salmon and other native fish species remain susceptible to stranding as a result of entering the lower end of the Colusa Basin Drain. The vision is to provide a long-term remedy to prevent adult fish, particularly chinook salmon, from entering the drain.

VISIONS FOR SPECIES

SPLITTAIL: The vision for splittail is to recover this federally listed threatened species. Improvements in the riparian and stream meander corridors along the Sacramento River will improve spawning and early rearing habitat of splittail. Late-winter and early-spring streamflow improvements will provide attraction flows for spawning adults and increased spawning habitat. The vision is that restoration of ecological processes and habitats, along with a reduction of stressors, will contribute to a stable and larger splittail population.

Because of its distribution, restoration actions implemented in the following Ecological Management Zones will contribute to the recovery of splittail: Sacramento River, East San Joaquin, San Joaquin River, Sacramento-San Joaquin Delta, Suisun Marsh/North San Francisco Bay, Colusa Basin, Feather River/Sutter Basin, American River Basin, and Yolo Basin. Many of the related actions include restoring ecological processes linked to natural floodplains and flood processes.

WHITE STURGEON AND GREEN STURGEON: The vision for green sturgeon is to recover this California species of special concern and restore population distribution and abundance to historic levels. The vision for white sturgeon is to maintain and restore population distribution and abundance to historic levels to support a sport fishery. Improved peak flows in late winter and early spring will benefit sturgeon spawning. Improved stream meander corridors should also benefit sturgeon. The vision is that restoration of ecological processes and habitats, along with a reduction of stressors, will contribute to stable and larger sturgeon populations.

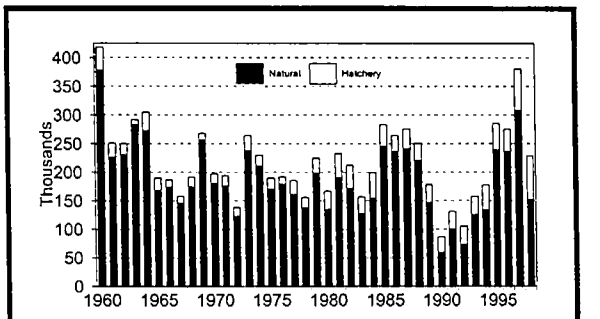
Green sturgeon is a legal sport fish in California, Oregon, and Washington. The Bay-Delta system constitutes the southernmost reproducing populations of green sturgeon. There is no direct evidence that green sturgeon have declined in the Sacramento River, but the population is quite small, and a collapse could occur under some conditions. Green sturgeon require additional focused research on life history, distribution and abundance.

Similar to restoration actions for white sturgeon, actions that will contribute to the protection and restoration of green sturgeon will occur in the Sacramento River, Feather River, Sacramento-San Joaquin Delta, and Suisun Marsh/North San Francisco Bay Ecological Management Zones.

Although the California Department of Fish and Game and USFWS have set population and harvest goals, actions to accomplish the Ecosystem Restoration Program Plan (ERPP) target will be achieved by restoration actions undertaken and completed in the Sacramento River, Feather River, Sacramento-San Joaquin Delta, and Suisun Marsh/North San Francisco Bay Ecological Management Zones.

CHINOOK SALMON: The vision for Central Valley chinook salmon is to recover all stocks presently listed or proposed for listing under ESA and CESA, achieve naturally spawning population levels that support and maintain ocean commercial and ocean and inland recreational fisheries, and use fully existing and restored habitat.

Four races of chinook salmon will benefit from improved streamflows, gravel recruitment, water temperatures, riparian and riverine aquatic habitat, and stream meander corridors. The vision is that restoration of ecological processes and habitats, along with a reduction of stressors, will contribute to stable and larger chinook salmon populations.



Sacramento Valley Fall-run Chinook Salmon Returns, 1960-1998 (CDFG 1999).

Each of the major chinook salmon restoration /recovery programs has developed specific goals for Central Valley chinook salmon stocks. ERPP embraces each of the restoration/recovery goals and will contribute to each agency's program by restoring critical ecological processes, functions, and habitats, and by reducing or eliminating stressors. ERPP's approach is to contribute to managing and restoring each stock with the goal of maintaining cohort replacement rates of much greater than 1.0 while the individual stocks are rebuilding to desired levels. When the stocks approach the desired population goals, ERPP will contribute to maintaining a cohort replacement rate of 1.0.

STEELHEAD TROUT: The vision for steelhead trout is to recover this species listed as threatened under ESA and achieve naturally spawning populations of sufficient size to support inland recreational fishing and that use fully existing and restored habitats.

Steelhead will benefit from improved streamflows and gravel recruitment in the upper river and improved water temperature and riverine habitat in the upper, middle, and lower reaches of the river. The vision is that restoration of ecological processes and habitats, along with a reduction of stressors, will contribute to stable and larger steelhead populations.

Operation of the water storage and conveyance systems throughout the Central Valley for their potential ecological benefits can be one of the more important elements in restoring a wide spectrum of ecological resources, including steelhead trout.